Late Famennian correlation by miospores between the Refrath 1 borehole (Bergisch Gladbach-Paffrath Syncline, Germany) and the reference section of Chanxhe (Dinant Syncline, Belgium).

[Corrélations par miospores au Famennien supérieur entre le sondage de Refrath 1 (Synclinal Bergisch Gladbach-Paffrath, Allemagne) et la section de référence de Chanxhe (Synclinorium de Dinant, Belgique)]

Maurice STREEL[1]

Christoph HARTKOPF-FRÖDER[2]

Key Words: Famennian; miospores; Germany; Belgium; biostratigraphy

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Mots-Clefs : Famennien ; miospores ; Allemagne ; Belgique ; biostratigraphie

The Bergisch Gladbach-Paffrath Syncline and the Dinant Syncline are both part of the Ardennes-Rhenish Massif but are separated by some 100 km (Fig. 1).

In the Upper Devonian succession of the Bergisch Gladbach-Paffrath Syncline (The Bergisches Land), the Knoppenbissen Formation is assigned the "Dasbergian" (HARTKOPH-FRÖDER *et alii*, 2004). In this syncline the thermal alteration index (TAI of 2 to 2+) is remarkably low compared to that of other Upper Devonian sediments in the Ardenne-Rhenisch area. Due to this low thermal maturity the preservation of miospores is very good to excellent (HARTKPF-FRÖDER & STREEL, 1994; HARTKOPF-FRÖDER, 2004). The sedimentary rocks of the Refrath 1 borehole are mainly dark grey, partly calcareous mudstones; rare marlstone intercalations are considered to be fine-grained turbidites. Both contain many fossils. Aside from the very well preserved miospores of the *Retispora lepidophyta – Knoxisporites literatus* (LL) miospore Zone, numerous other microfossils are known *i.e.* conodonts (PIECHA, 2004) and entomozoacean ostracodes (GROOS-UFFENORDE, 2004). Some characteristic ammonoid species are present in the lowermost part of the borehole (KORN, 2004).

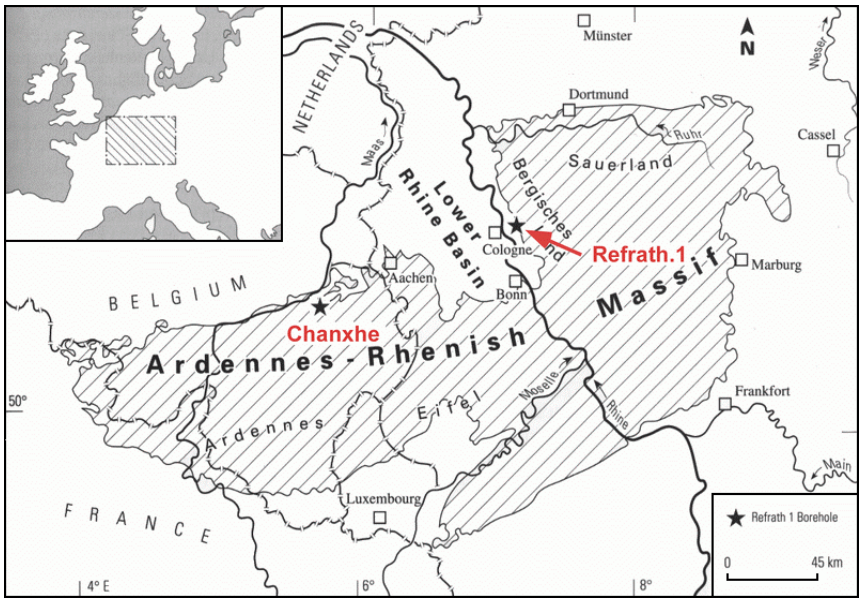

Figure 1: The Ardennes-Rhenish Massif and the location of the reference section and borehole, respectively in a neritic (Chanxhe) and a pelagic (Refrath 1) facies.

[1] *Département de Géologie, Université de Liège, Allée du 6 août, B18, Sart-Tilman, 4000 Liège (Belgium)*

[2] *Geologisches Landesamt Nordrhein-Westphalen, De-Greiff-Str. 195, Postfach 1080, D-47710 Krefeld (Germany)*

In the Dinant Syncline, the Comblain-au-Pont Formation is assigned the "Strunian". Thermal alteration is rather high; therefore miospores in the formation are dark brown. Farther east, the Comblain-au-Pont Formation, the time-equivalent in Belgium of the French Etroeungt Formation, is made up of some dm- to several m-thick beds of green shale and siltstone interbedded with micaceous, argillaceous or calcareous sandstones. From bottom to top three lithologic units may be distinguished: a shale dominant unit, a sandstone dominant unit and a carbonate dominant unit (CONIL, 1964). The latter is the equivalent of the Etroeungt Limestone *s.s.* (BULTYNCK & DEJONGHE, 2001). The Chanxhe road section (Ourthe valley, eastern Belgium) displays the three lithologic units of the Comblain-au-Pont Formation. It is a site where miospores, foraminifers and conodonts have been described and occur in a sequence permitting intercorrelation of faunal components. Above the base of the *Retispora lepidophyta–Knoxisporites literatus* (LL) miospore Zone, between the Df3δ and Df3ε foraminifer faunas, a late *expansa* conodont fauna is present. And above the Df3ε foraminifer fauna the succeeding *Retispora lepidophyta–Indotriradites explanatus* (LE) miospore Zone occurs. Benthic ostracodes belong to the "Eifelian Mega-Assemblage" (CASIER *et alii*, 2005) and allow ecological interpretation. In the Chanxhe section a decrease upward in the diameter of *Retispora lepidophyta* has been examined in great detail by MAZIANE *et alii* (2002). They reports a significant shift of mean size (more than or less than 60 µm) near the base of the carbonate dominant unit (around bed 115 on Fig. 1). This shift allows the recognition of two varieties of *Retispora lepidophyta*, *i.e. R. l.* var. *lepidophyta* dominant below and *R. l.* var. *minor* dominant above. Comparison with the range of sizes in other miospores supports the conclusion that this decrease is not the result of a process of sorting in the carbonate facies but rather a consequence of some evolutionary process.

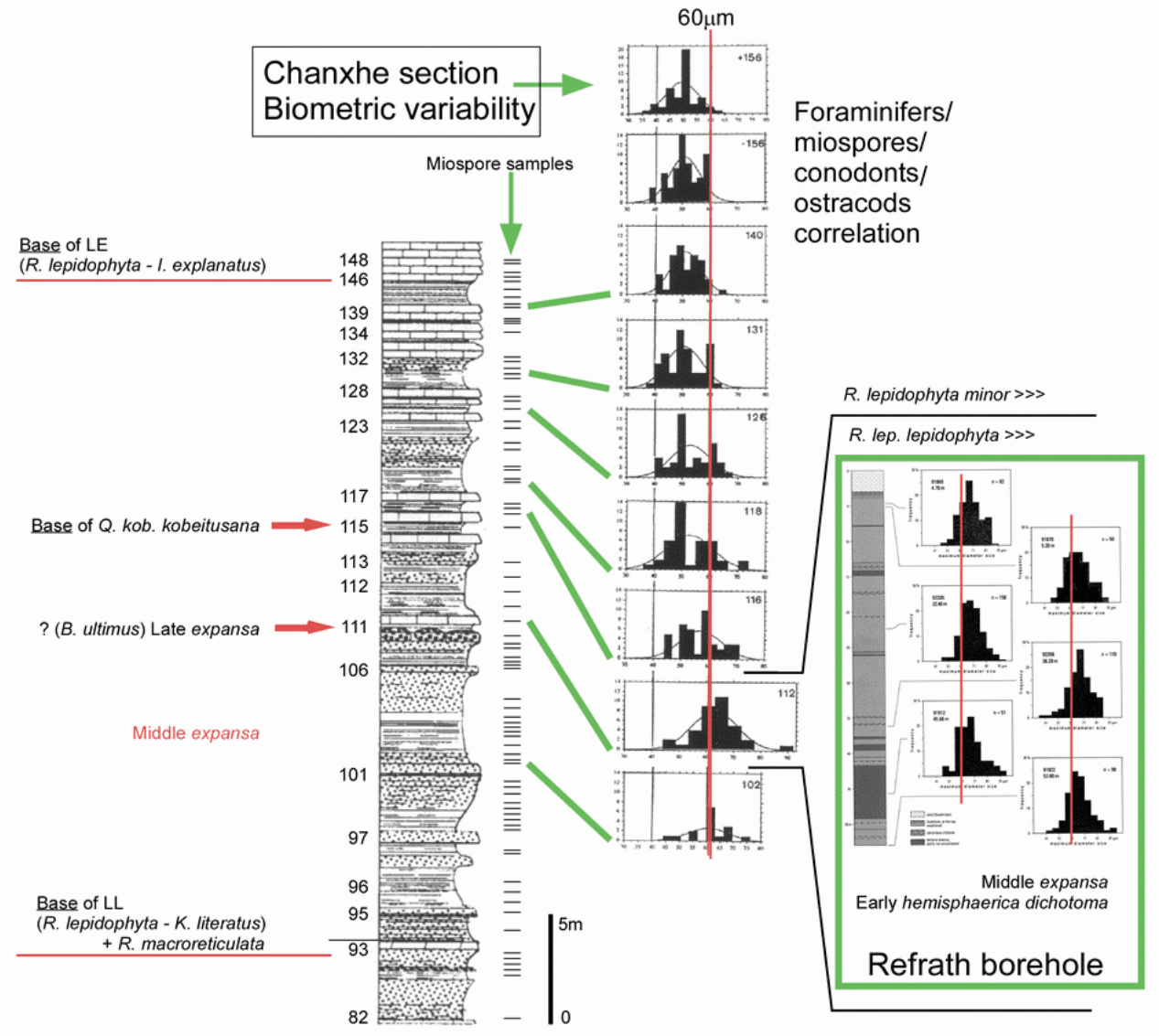

Figure 2: Late and latest Famennian biostratigraphic correlation between the Comblain-au-Pont Formation at Chanxhe and the Knoppenbissen Formation in the Refrath borehole.

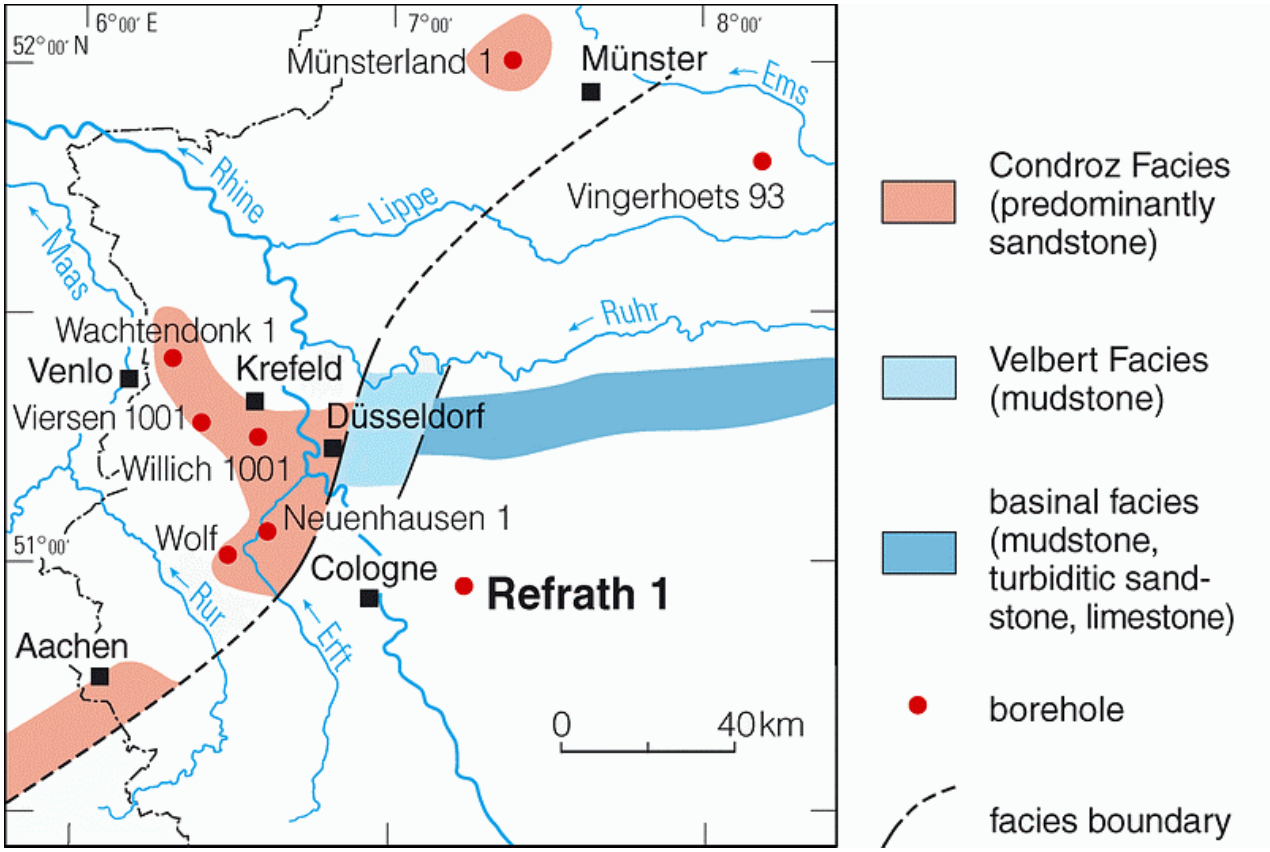

Figure 3: Location of the Refrath 1 borehole in the basinal facies of the Bergisch Gladbach-Paffrath Syncline.

The Chanxhe road section is a candidate reference section, in a neritic facies, for the transition between late Famennian and latest Famennian. Although an international agreement has yet not been reached to define lower limits of substages within the Famennian Stage, a subdivision into 4 substages has been adopted internationally. A proposal for a conodont-based definition of the lower limit of the uppermost Famennian at the base of the late *expansa* Zone (STREEL, 2005) is still under consideration by the International Subcommission on Devonian Stratigraphy and, in this context, a search for a good reference section in a neritic facies is more important than ever.

The base of the late *expansa* Zone is absent in the Chanxhe section but new data from the Refrath 1 borehole allow this gap in our knowledge to be filled. In the Refrath 1 borehole, the lower part of the LL miospore Zone (which includes the presumed ancestral *Retispora macroreticulata* and large specimens of *R. lepidophyta*) is the equivalent of the medial portion of the *expansa* conodont Zone and the early part of the *hemisphaerica* – *dichotoma* entomozoacean Zone. The conclusion is that the base of the late *expansa* conodont Zone and the base of the *Q. kob. kobeitusana* (Df3ε) foraminifer Zone are obviously much closer together than was believed previously (Fig. 2).

The few characteristic ammonoid species in the lowermost part of Refrath 1 suggest an age slightly older than the age indicated by the 3 groups of abundant microfossils (GROOS-UFFENORDE, 2004; HARTKOPF-FRÖDER, 2004; PIECHA 2004). This can be explained only if we accept that during their transport down the slope (Fig. 3) the turbiditic flows removed by erosion the upper levels of some limestone shoals or else that at present only a portion of the ammonoid fauna of the Knoppenbissen Formation is known.

The facies relationships shown here indicate that the turbiditic flows on the slope started when the transgression on the shelf (MAZIANE *et alii*, 2002, p. 222) had reached its maximum and was succeeded by cyclic regressive phases.

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